ureter, the largest number of kidney carcinomas occur in the renal parenchyma and are adenocarcinomas.

In retrospective studies, adenocarcinomas of the kidney are found more frequently in smokers compared with non-smokers in both men and women (43,44). In a large prospective study among U.S. veterans, the kidney cancer mortality ratio increased from 1.0 (the baseline for nonsmokers) to 1.34 for those who smoked 10 to 19 cigarettes daily and to 2.75 for men who smoked two packs or more each day (18). No large scale prospective study of women and kidney cancer has been reported to date.

Pancreas

Carcinoma of the pancreas will occur in 12,500 men and 11,500 women in the United States during 1980, and 11,100 men and 9,800 women will die of pancreatic carcinoma (1). During the past 25 years, there has been a steady increase in both the incidence and mortality due to pancreatic cancer in both men and women (1,21). Among the common human neoplasms, the rate of increase of pancreatic cancer over the past quarter century has been second only to that of the lung.

Most pancreatic carcinomas are adenocarcinomas, arising from ductal cells (24). Most are relatively undifferentiated in cell type. The median survival time from histologic proof of diagnosis to death is 3.5 months in men and 4.5 months in women. Survival time varies little with age at time of diagnosis, duration of symptoms, location of primary lesion (head, body, or tail of pancreas) or even degree of differentiation. The 5-year survival rate is one percent, the most dismal survival rate for any of the common neoplasms of either men or women (1).

Retrospective studies relating smoking to pancreatic carcinoma have been reviewed in previous reports. In a prospective study of 143,000 women, the pancreatic cancer mortality ratio was 1.94 for Japanese women smokers compared to nonsmokers (14). In Sweden, a smaller prospective study showed that the mortality ratio for pancreatic cancer was 2.5 for women smokers compared to women nonsmokers (4).

In the United States, the male to female ratio of pancreatic cancer was 1.6 in the 1940s. It has decreased to the current estimate of 1.17 for 1979 and is consistent with the decreasing male to female ratios of lung and laryngeal carcinomas.

Summary

1. Cigarette smoking is causally associated with cancer of the lung, larynx, oral cavity, and esophagus in women as well as in men; it is also associated with kidney cancer in women.

2. Cigarette smoking accounts for 18 percent of all newly diagnosed cancers and 25 percent of all cancer deaths in women. In 1980, 26,500 of the estimated 101,000 deaths, or over one-quarter of the deaths expected from lung cancer, will occur in women.

3. Women cigarette smokers have been reported to have between 2.5 and 5 times greater likelihood of developing lung cancer than nonsmoking women.

4. Among women the risk of developing lung cancer increases with increasing number of cigarettes smoked per day, duration of the smoking habit, depth of inhalation, and tar and nicotine content of the cigarette smoked. The risk is inversely related to the age at which smoking began.

5. A dose-response relationship has been demonstrated between cigarette smoking and cancer of the lung, larynx, oral cavity, and urinary bladder in women.

6. The rise in lung cancer death rates is currently much steeper in women than in men. It is projected that the age adjusted lung cancer death rate will surpass that of breast cancer in the early 1980s.

7. The rapid increase in lung cancer rates in women is similar to but steeper than the rise seen in men approximately 25 years earlier. This probably reflects the fact that women first began to smoke in large numbers 25–30 years after the increase in cigarette smoking among men. Thus, neither men nor women are protected from developing lung cancer caused by cigarette smoking.

8. Cigarette smoking has been causally related to all four of the major histologic types of lung cancer in both women and men, including epidermoid, small cell, large cell and adenocarcinoma.

9. The use of filter cigarettes and cigarettes with lower levels of "tar" and nicotine by women is correlated with a lower risk of cancer of the lung and larynx compared to the use of high-"tar" and nicotine or unfiltered cigarettes. The risk posed by smoking low-"tar" cigarettes, however, is clearly greater than that among females who never smoked.

10. After cessation of cigarette smoking, a woman's risk of developing lung and laryngeal cancer has been shown to drop slowly, equalling that of nonsmokers after 10–15 years.

11. Excessive ingestion of alcohol acts synergistically with cigarette smoking to increase the incidence of oral and laryngeal cancer in women.

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NON-NEOPLASTIC BRONCHOPULMONARY DISEASES.

NON-NEOPLASTIC BRONCHOPULMONARY DISEASES

Introduction

Chronic non-neoplastic bronchopulmonary disorders are a major cause of death and disability in the United States. Chronic obstructive lung diseases (COLD), including chronic bronchitis and emphysema, comprise the majority of these illnesses. In 1977, they were responsible for nearly 46,000 deaths and millions of dollars in social security disability payments, ranking second in economic cost only to heart disease (42).

Previous U.S. Public Health Service reports on the health consequences of smoking have presented evidence that cigarette smoking is the major cause of COLD (55–64). The studies on which this is based have focused primarily on male populations. This reflects the scientific interest generated by the overwhelming male-to-female ratio in the prevalence of COLD at the time these studies began. However, recent mortality statistics indicate a substantial increase in the death rate from COLD among women (see Mortality section). Although this increased death rate may partially reflect a greater awareness and recognition of COLD, its magnitude suggests a true increase in frequency of COLD among women. The following text reviews a large number of studies analyzing the relationship of smoking to COLD. These studies include appreciable numbers of women, and many suggest that smoking may affect men and women differently. Nevertheless, cigarette smoking remains the most important cause of COLD regardless of sex or other variables.

Definitions

The terms chronic bronchitis and emphysema have been used diagnostically for many years. Physicians often use these terms interchangeably to describe a patient with chronic airflow obstruction. These conditions are, however, difficult to distinguish from each other in patients with chronic airflow obstruction because (a) both conditions may be present in the same patient; (b) both disorders are characterized by expiratory flow obstruction; and (c) patients with either disorder frequently have the same symptom—dyspnea on exertion. Consequently, the clinician often labels the patient with chronic airflow obstruction as having chronic obstructive lung disease (COLD). Many attempts have been made to establish criteria for the diagnosis of chronic bronchitis and emphysema (1,27,28). The most widely accepted definitions in the United States are those

TABLE 1.—Age-adjusted death rates from COLD (ICDA 490–492 and 519.3) 1960–1977 (per 100,000)

	White		Nonwhite	
	Male	Female	Male	Female
1977	33.4	10.7	14.8	3.5
1976	33.5	10.1	14.9	3.2
1975	32.1	9.1	13.5	3.3
1974	31.1	8.4	13.7	2.8
1973	31.4	7.8	14.1	3.0
1972	29.9	7.0	14.0	2.9
1971	28.6	6.5	13.2	3.0
1970	28.2	6.0	13.3	2.6
1969	27.3	5.4	12.8	2.4
1968	22.3	3.8	13.7	2.5
1967	19.9	3.1	11.5	2.0
1966	19.7	3.0	11.0	1.9
1965	18.4	2.7	10.4	1.8
1964	16.1	2.4	9.2	1.6
1963	15.9	2.3	9.5	1.9
1962	13.1	2.0	7.7	1.8
1961	10.9	1.7	7.0	1.3
1960	10.4	1.7	6.7	1.4

SOURCE: National Center for Health Statistics (42).

of a joint committee of the American College of Chest Physicians and the American Thoracic Society (1).

"Bronchitis: A non-neoplastic disorder of structure or function of the bronchi resulting from infectious or noninfectious irritation. The term bronchitis should be modified by appropriate words or phrases to indicate its etiology, its chronicity, the presence of associated airways dysfunction or type of anatomic change. The term chronic bronchitis, when unqualified, refers to a condition associated with prolonged exposure to nonspecific bronchial irritants and accompanied by mucous hypersecretion and certain structural alterations in the bronchi. Anatomic changes may include hypertrophy of the mucous-secreting apparatus and epithelial-metaplasia, as well as more classic evidence of inflammation. In epidemiologic studies, the presence of cough or sputum production on most days for at least 3 months of the year has sometimes been accepted as a criterion for diagnosis."

"Pulmonary Emphysema: An abnormal enlargement of the air spaces distal to the terminal nonrespiratory bronchiole, accompanied by destructive changes of the alveolar walls. The term emphysema may be modified by words or phrases to indicate its etiology, its anatomic subtype, or any associated airway dysfunction."

"Chronic Obstructive Lung Disease: This term refers to a disease of uncertain etiology characterized by persistent slowing of airflow during forced expiration. It is recommended that a more specific term, such as chronic obstructive bronchitis or chronic obstructive emphysema, be used whenever possible."

It should be noted that these definitions may have serious inadequacies, particularly when applied to longitudinal studies assessing the natural history of COLD (29,52). In the following discussion, these limitations are recognized.

Smoking and Respiratory Mortality

Recent mortality statistics indicate a striking increase in death rate from COLD among women (42). These data presented in Table 1 indicate a nearly fivefold increase in reported mortalities due to COLD from 1962 to 1977 among white females and a twofold increase among nonwhite females. Mortality rates from these conditions for white and nonwhite males have also increased since 1967 (by factors of 1.9 and 1.5, respectively), but the rate of increase has not been as steep as that for women.

Seven large prospective studies have shown a greatly increased mortality from COLD among smokers as compared to nonsmokers (14,18,19,31,32,37). These studies, presented in Table 2, represent over 13 million subject years of observation and approximately 270,000 deaths from all causes. The number of deaths related to COLD is probably underestimated since some of the deaths attributed to pneumonia or myocardial disease may have been due to complications of COLD. In addition, these mortality figures do not include an appreciable number of individuals for whom COLD may have been a major contributory cause of death. For example, it is not uncommon for individuals to have COLD and lung cancer simultaneously.

Two of these prospective studies have included significant numbers of women. Hammond prospectively followed 1,003,229 subjects aged 35 to 84 (31). Nearly 93 percent of the survivors were observed for a 12-year period. Death rates from emphysema among women were much higher in cigarette smokers than nonsmokers. "Heavier" smokers (defined as either smokers of 20 or more cigarettes a day regardless of age when smoking was begun, or smokers of 10 or more cigarettes a day who had begun smoking before age 25) had a sevenfold increased mortality rate as compared to nonsmokers. Cederlof et al. followed 55,000 Swedish subjects aged 10 to 69 for 10 years (14). The overall mortality rate from all causes among female smokers was 1.2 times higher than that of female nonsmokers. The death rate from bronchitis, emphysema, and asthma among

TABLE 2.—COLD mortality ratios + in seven prospective studies

Study (Reference)	British Doctors (18)	Women in 25 States 45–65 (31)	Men in 25 States 45–64 (31)	Men in 25 States 65–79 (31)	U.S. Veterans (37)	Canadian Veterans (8)	Men in 9 States (32)	California Occupations (19)	Swedish Subjects Females (14)	Swedish Subjects Males (14)
Emphysema and/or bronchitis	24.7	—	—	—	10.08	—	2.30	4.3	—	—
Emphysema without bronchitis	—	4.89	6.55	11.41	14.17	7.7	—	—	—	—
Bronchitis	—	—	—	—	4.49	11.3	—	—	—	—
Bronchitis, emphysema and asthma	—	—	—	—	—	—	—	—	2.2	3.7*

+ Death rate for smokers divided by death rate of a comparable group of nonsmokers.
*For all ages combined; increased mortality rate significant only for former smokers.

female smokers was 2.2 times that of female nonsmokers. However, the number of deaths due to COLD among women was small in both of these studies; consequently, the relationship with smoking is more difficult to evaluate. Nevertheless, a significant excess risk for reported mortality from COLD was present for female cigarette smokers as compared to female nonsmokers.

Data collected by Doll et al. examine the association of smoking and cause-specific mortality in 6,194 women physicians in England, observed prospectively over the period 1951 to 1973 (17). Table 3 presents the results of this study, including previously published results of a similar study among male physicians over the same period (18). The association of smoking and chronic bronchitis clearly observed in males was confirmed in women physicians. For both women and men who reported smoking 15 or more cigarettes per day, the mortality rate due to emphysema and chronic bronchitis was more than five times as great as in nonsmokers. In both sexes, mortality due to emphysema and chronic bronchitis was more than double that of nonsmokers, was at least three times as high in ever-smokers as in never-smokers, and was at least twice as high in current heavy smokers ($\geq$25 cigarettes) as in light smokers ($\leq$15 cigarettes).

The risk of death from emphysema and chronic bronchitis associated with smoking was approximately similar in men and women. For moderate (1 to 14 cigarettes per day) and heavy ($\geq$25 cigarettes per day) smokers, compared with nonsmokers, the relative risk of death was 28.5 and 32 for women, respectively, versus 16.7 and 29.3 for men. In this data, as well as that for lung cancer, there is no support for the contention that women are less susceptible to harmful effects of smoking than are men. The authors emphasize that no conclusions can be drawn from this data about the magnitude of the biologic effects of smoking in men compared to women. Attempts to document differences in lifetime smoke exposure (later age at initiation and lower prevalence of inhalation among females) demonstrate that lifetime smoking exposures between the sexes are not comparable. This issue will be resolved only when studies examine the effect of smoking in cohorts of women whose lifetime smoking behavior more closely matches that of the men to whom they are compared.

In comparing the relative risks for mortality from COLD in female and male smokers (Table 2), it is apparent that female smokers have lower reported mortality rates than their male counterparts. This difference in mortality rates may be due to differences in female smoking patterns (31). Women tend to

TABLE 3.—Death rates from chronic bronchitis and emphysema by smoking habit when last asked, British physicians 1951–1973

			Annual Death Rate Per 100,000 Persons Standardized for Age					X^2	
					Current Smokers—Dose Per Day				
	Total Popul.	# Deaths	Non-Smokers	Ex-Smokers	1–14	15–25	>25	Nonsmokers vs. All Others	Trend (Dose/ Response)
Women	6,194	13	2	10	21	57 (cigarettes only)	64	12.34*	26.64*
Men	34,440	254	3	44	38	50 (any tobacco/grams) (1 gram = 1 cigarette)	88	25.58*	47.23*

*(P >0.001)
SOURCE: Doll, R. (17,18).

smoke fewer cigarettes, inhale less deeply, and begin smoking later in life than men. They more frequently smoke filtered and low-tar and -nicotine cigarettes and have less occupational exposure to lung irritants than men. Recent data suggest that women are manifesting smoking patterns similar to those of men. Moreover, more women are joining the labor force, including occupations where exposure to lung irritants may occur. (See section on Occupational Exposures.) Whether these women will continue to have mortality rates different from those of men remains to be determined.

In summary, recent statistics indicate a rise in the reported death rate due to COLD among women. The two large prospective studies that included appreciable numbers of women found significantly higher mortality rates due to COLD among women smokers as compared to women nonsmokers. This relationship was accentuated in heavier smokers. Mortality rates from COLD among female smokers are considerably lower than among male smokers. This may be due to different smoking patterns and work exposure among men and women.

Smoking and the Epidemiology and Pathology of COLD

The prevalence of chronic bronchitis has been determined in several populations in the United States and in other countries (24,25,26,34,36,41,43,44,46,51). Table 4 lists several studies which have included appreciable numbers of women. These studies have documented a close relationship between cigarette smoking and an increased prevalence of chronic bronchitis, and when looked for, a dose-response relationship was also present (Table 3). The prevalence of chronic bronchitis in the United States was determined in four cohort studies and ranged from 4 to 10 percent among women and 14 to 18 percent among men (24,25,26,41,44,51). In both men and women a dose-response relationship between the number of cigarettes smoked and the prevalence of chronic bronchitis was apparent.

The observed differences between men and women noted in these studies may be due in part to the smaller percentage of women than men who were smokers in the population studied. Moreover these women smoked fewer cigarettes than men. When comparing current smokers, several studies of different populations in the United States and in England did not find significant differences in the prevalence of chronic bronchitis between men and women (21,33,41).

The relationship between smoking and pathologic changes in the lung have largely been obtained by necropsy studies. These investigations are often skewed by physician and/or hospital

TABLE 4.—Prevalence of chronic bronchitis by smoking classification (numbers in parentheses represent total number of individuals in particular smoking group)

	S = Smokers	NS = Nonsmokers	EX = Ex-Smokers	
Author, Year Country (Reference)	Number and Type of Population	Men	Women	Comment
Higgins, 1958 England (34)	94 men and 92 women randomly chosen from agricultural communities	NS ..... 0.0 S 6.7	NS ..... 0.0 S 5.0	
Oswald, 1955 England (43)	3,602 males and 2,242 female clerical workers 40–65 yrs. of age	NS ..... 15.8 (474) S 18.4 (1,940)	NS ..... 12.1 (619) S 18.8 (579)	Chronic bronchitis defined by habitual cough and sputum production
Hubti, 1965 England (36)	653 men and 823 women in a Finnish rural community 40–60 yrs. of age	NS ..... 5.7 EX ..... 16.3 S 1–14 ..... 38.0 15–24 ..... 41.4 >25 ..... 4.0	NS ..... 4.5 EX ..... 13.3 S 1–14 ..... 10.4 15–24 ..... >25 ..... 57.0	Ex-smokers represent those who have stopped for more than 1 month
Remington, 1969 England (46)	41,729 men and 22,295 women participating in mass miniature radiography screening	NS ..... 5.1 (9,055) EX ..... 9.8 (6,510) Cigarettes ..... (23,243) S 1–19 ..... 9.1 10–19 ..... 15.0 >20 ..... 20.6	NS ..... 3.4 (12,351) EX ..... 3.9 (959) Cigarettes ..... (8,985) S 1–9 ..... 5.1 10–19 ..... 10.6 >20 ..... 18.5	Age-adjusted total prevalence. Cigarette dosage gradient significant to $P < 0.001$

Ferris, 1962 U.S.A. (23,25,26)	542 men and 625 women residents of New Hampshire town chosen by random sampling of census	Overall NS ..... 13.8 (125) EX ..... 11.9 (77) Cigarettes ... 40.3 (340) 1-10 ..... 29.8 11-20 ..... 34.2 21-30 ..... 42.3 31-40 ..... 61.1 >41 ..... 75.3	Overall NS ..... 9.4 (378) EX ..... 10.8 (37) Cigarettes ... 19.8 (208) 1-10 ..... 13.1 11-20 ..... 22.2 21-30 ..... — 31-40 ..... 27.3 >41 ..... —	Age-specific rates
Payne, 1964 U.S.A. (44)	5,140 adult residents of Tecumseh, Mich.	Overall 8	Overall 4	Prevalence rates estimated from line graph
Mueller, 1971 U.S.A. (41)	281 men and 328 women residents of Glenwood Springs, Colo.	Overall ..... 17 (281) NS ..... 3 (2) EX ..... 13 (7) S 1-14 ..... 11 (3) 15-24 ..... 20 (13) >25 ..... 38 (21)	Overall ..... 10 (328) NS ..... 2 (3) EX ..... 5 (1) S 1-14 ..... 14 (7) 15-24 ..... 25 (14) >25 ..... 33 (9)	
Tager, 1976 U.S.A. (51)	227 men and 280 women in East Boston, Mass. age 15 or greater	Overall ..... 14.7 (227) NS ..... 5.8 S 24.2	Overall ..... 7.5 (285) NS ..... 1.8 S 17.6	Age-adjusted prevalence rate

interest and may not accurately represent a random population. Moreover, observer variation occurs frequently, even among "experts." Data regarding smoking history are usually derived from a hospital record or from close relatives and friends; thus they may be unreliable.

Only a few of the studies examining the relationship of cigarette smoking to the frequency and severity of pathological changes have included significant numbers of female subjects. Thurlbeck recently reviewed 30 reported surveys of the frequency of emphysema at necropsy (53). Emphysema of some degree was found in about 65 percent of men and 15 percent of women. The emphysema found was also more severe in men than in women.

The predominant pathological finding in chronic bronchitis is the hypertrophied mucous gland in the submucosa of the large cartilaginous bronchi. The ratio of bronchial gland thickness to bronchial wall thickness (Reid index) is usually increased. In a recent survey of 179 consecutive necropsies, Ryder et al. found significantly greater bronchial mucous gland volume in smokers compared to nonsmokers. There was no significant difference in mucous gland volume between male and female smokers or male and female nonsmokers (48).

Mueller et al. examined the prevalence of chronic bronchitis in one-fifth of the adult population of Glenwood Springs, Colorado (41). Among current smokers of varying smoking categories (Table 4) there were no significant differences in the prevalence of chronic bronchitis. Higgins and Cochran found no significant difference in the prevalence of chronic bronchitis between men and women smokers in 186 subjects randomly chosen from an agricultural community (Table 4) (34). Similarly, Oswald and Medvel found no significant difference in the prevalence of chronic bronchitis between men and women smokers in 5,844 clerical workers in England (Table 4) (43).

Auerbach et al. examined the relationship of smoking to emphysema in whole-lung and microscopic sections at necropsy in 1,436 men and 388 women (4,5). Among the women, there were 97 current smokers, 16 of whom smoked two packs a day or more. Data regarding smoking habits were obtained through interviews with relatives. Female smokers had a significantly higher rate of emphysema than female nonsmokers (Table 5). Furthermore, the severity of the emphysema was dose-related to the number of cigarettes smoked. The authors found similar relationships in men.

Spain et al. examined consecutive whole-lung mounts from necropsies of adult victims (49 women, 85 men) of sudden and unexpected death (50). Smoking habits were ascertained by a

letter and questionnaire to the next of kin. The degree of emphysema was graded from 0 to 100 by two observers independently and without prior knowledge of the source of the specimen or any previous grading. There was a close relationship between cigarette smoking and the degree of emphysema in both men and women. Furthermore, the data (Table 6) demonstrated a dose-response effect between the number of cigarettes smoked and the severity of pathological changes.

Thurlbeck et al. examined whole-lung sections in 1,742 random necropsies in three different cities in different countries with varying climates and environments (54). Using a standard panel of grading pictures, pathologic changes in the lung were graded from 0 to 100 by the three readers. In men and women emphysema was more frequent and more severe in smokers than nonsmokers; however, male smokers had higher average emphysema scores and greater frequency of emphysema than female smokers and nonsmokers. This difference between men and women was also true when heavy smokers and ex-smokers of both sexes were compared. The authors speculate that male-female differences may exist because: (a) women are protected by hormonal factors; (b) men may smoke more heavily than women; (c) men may have different smoking patterns than women, e.g., inhalation; and (d) men may be exposed to damaging environmental factors at work.

TABLE 5.—Means of average degrees of findings* in nonsmokers and current smokers standardized for age of total study population, women

	Subjects Who Never Smoked Regularly	Current Cigarette Smokers	
		<1 Pk.	1 +Pk.
Number of subjects	252	33	64
Emphysema	0.05	1.37	1.70
Fibrosis	0.37	2.89	3.46
Thickening of arterioles	0.06	1.26	1.57
Thickening of arteries	0.01	0.40	0.64

*The pathologic findings recorded were: (1) degree of emphysema (four-point scale ranging from zero for normal to four for advanced emphysema); (2) degree of fibrosis (seven-point scale ranging from none to advanced diffuse fibrosis); (3) degree of thickening of arterioles (four-point scale); (4) degree of thickening of arteries (three-point scale); and (5) padlike attachments to alveolar septa. Padlike attachment is a thickening of alveolar septa in focal areas by fibroblasts, histocytes and collagen fibrils. This is recorded as present or absent.

SOURCE: Auerbach, O. (4).

In summary, the prevalence of chronic bronchitis among women in the United States has been reported to range from 4 to 10 percent. Women who smoke have a higher prevalence of chronic bronchitis than those who do not smoke. Overall, however, chronic bronchitis is less common among women than men in the United States. This may reflect the smaller proportion of women who smoke, differences in their smoking behavior, and less occupational exposure to lung irritants. When comparing current smokers, several studies of different populations in the United States and England did not find significant differences in the prevalence of chronic bronchitis between men and women. Pathological data suggest that female smokers have a higher frequency of emphysema and bronchial mucous gland hypertrophy than female nonsmokers. Furthermore, the severity of emphysema is dose-related to the number of cigarettes smoked. Distinct female-male differences in the frequency and extent of emphysema at autopsy have been reported, but it is not clear whether these differences are due to intrinsic differences in the way men and women respond to environmental injury or to the differences in the degree of environmental injury experienced by men and women.

Smoking and Respiratory Morbidity

A large number of recent studies have demonstrated a higher frequency of respiratory symptoms, i.e., cough, sputum, wheezing and dyspnea, in smokers as compared to nonsmokers. Many

TABLE 6.—Degree of emphysema* and cigarette smoking**

Cigarettes Per Day	No. Over Age 30	Mean Grade of Emphysema	No. With Grade 20 Emphysema	Mean Age With Grade 20 Emphysema
Men				
0	30	8 (0–20)	3 (10%)	66
<21	14	11 (0–45)	5 (36%)	62
>20	41	14 (0–50)	16 (39%)	52
Women				
0	21	2 (0–10)	0	—
<21	6	6 (0–20)	1 (17%)	70+
>20	22	8 (0–30)	5 (23%)	40

*x^2 test shows significance at the 1% level for the heavy smokers and nonsmokers.

**Each whole lung paper mounted section was graded from 0 to 100 in denominations of 5 up to grade 50 and then in denominations of 10 up to grade 100.

+One case.

SOURCE: Spain, D.M. (50).

of these studies have included appreciable numbers of women (9,11,15,38,39,40,45,47,65). These investigations have examined populations varying in age, geographic location, social class, and exposure to air pollution.

Leibowitz and Burrows examined the quantitative relationships between cigarette smoking and chronic productive cough in a large randomized sample of the white non-Mexican American population of Tucson, Arizona (38). Their data (Table 7) confirm the close relationship between cigarette smoking and chronic cough and/or chronic sputum production in men and women. The effect of cigarette smoking was closely related to the total pack-years smoked (Table 7). These data support the male to female preponderance in prevalence of chronic bronchitis noted in several other epidemiologic surveys (24,25,26,41,44,51). However, these data also indicate that males and females with equivalent smoking histories have similar rates of chronic cough and/or sputum production.

Woolf examined the frequency of respiratory symptoms in women volunteers, aged 25 to 54, drawn from several large commercial firms (Table 8) (65,66). The prevalence of cough and sputum production was significantly greater in smokers than in nonsmokers ($p < 0.001$). Heavier smokers complained of cough and/or sputum production more frequently than nonsmokers or ex-smokers. The prevalence of wheezing and exertional dyspnea increased progressively with the number of cigarettes smoked. In addition, colds that "went to the chest" occurred more frequently in moderate and heavy smokers than in nonsmokers ($p < 0.005$ and $p < 0.001$, respectively). Woolf compared his data with previously reported data among men (Table 9) and concluded that the relationship of cigarette smoking to respiratory symptoms was similar among men and women.

Ferris resurveyed a 1967 sample of Berlin, New Hampshire, residents in 1973 (22). As in 1967, the prevalence of cough and/or sputum production in females and males was directly related to the number of cigarettes smoked daily. When the group evaluated in 1967 was examined by current inhaling and smoking status (Figure 1), inhalers had a higher prevalence of symptoms than noninhalers (22). Furthermore, the frequency of symptoms was dose-related to the number of cigarettes smoked. Manfreda et al. studied population samples in an urban and a rural community in Manitoba, Canada (39). Their data presented in Table 10 demonstrate a higher prevalence of cough, phlegm, and wheezing among men and women who smoked than in nonsmokers or ex-smokers. However, no significant differences in the prevalence of symptoms were apparent in the two communities.

TABLE 7.—Comparison of prevalence of chronic cough+ and/or chronic sputum production+ in men and women, by smoking habits*

	(Number of Subjects) % With Symptoms							
	Never Smoked		Ex-Smokers		Presently 1–20/day		Presently >20/day	
A. By age group	Males	Females	Males	Females	Males	Females	Males	Females
15–29 years	(156) 7.2	(182) 8.2	(36) 8.3	(45) 17.7	(78) 25.7	(82) 20.8	(34) 41.2	(17) 41.1
30–44 years	(43) 2.3	(82) 12.2	(45) 11.1	(41) 4.8	(43) 39.5	(40) 35.0	(40) 47.5	(30) 56.7
45–59 years	(45) 11.1	(119) 10.9	(61) 21.3	(63) 20.6	(57) 43.8	(83) 36.2	(54) 61.1	(39) 51.3
60+ years	(105) 18.1	(336) 14.6	(186) 36.0	(77) 20.8	(62) 51.6	(82) 34.1	(16) 81.3	(14) 57.1

B. By pack-years of smoking	Present Smokers		Ex-Smokers	
Never smoked	(350) 10.3	(719) 12.1	(350) 10.3	(719) 12.1
Smoked < 6 pack-years	(69) 29.0	(81) 21.0	(59) 5.3	(69) 15.9
6–20 pack-years	(106) 35.8	(127) 33.1	(77) 14.3	(69) 15.9
21–40 pack-years	(96) 47.9	(126) 40.5	(86) 34.9	(27) 18.5
40+ pack-years	(113) 61.1	(53) 60.4	(106) 35.8	(30) 16.7

*Subjects with a history of childhood respiratory problems have been excluded from the analysis. Differences in rates by smoking significant within each age-sex group (X^2 and z differences between proportions) and trend with smoking significant within age-sex groups (X^2 trend). Trend of symptoms by pack-years significant for male present and ex-smokers and female present smokers (X^2 trend). Never smokers always significantly different from present or ex-smokers (X^2 and z).

+Symptoms are those reported on a self-completion questionnaire and are derived from the National Heart and Lung Institute modification of the British Medical Research Council respiratory questions. "Chronicity" of cough or sputum production refers to the presence of the symptom "on most days for at least three months of the year."

SOURCE: Leibowitz, M. (38).

TABLE 8.—Prevalence of cough and sputum production in 500 women related to smoking habit

	Nonsmokers		Ex-smokers		Light Smokers		Moderate Smokers		Heavy Smokers	
	No.	%	No.	%	No.	%	No.	%	No.	%
a. Cough*	11	6.0	1	1.6	11	27.5	32	34.8	66	53.7
b. Sputum**	14	7.7	1	1.6	12	30.0	27	29.3	60	48.8
c. Sputum volume										
None	169	92.3	61	98.4	28	70.0	65	70.7	63	31.2
Morning blob	10	5.5	0	0.0	7	17.5	11	12.0	29	23.6
Tablespoonful	3	1.6	0	0.0	5	12.5	12	13.0	17	13.8
More than one tablespoonful	1	0.5	0	0.0	0	0.0	4	4.4	12	9.8

*Includes women with cough with or without sputum.
**Includes women with sputum with or without cough.
SOURCE: Woolf, C.R. (65).

TABLE 9.—Prevalence of respiratory symptoms in men compared with women*

	Men (Published Data)	Women (Present Investigation)
Cough	Percent	Percent
Nonsmokers	4 (46) 14–22 (47)	6
Light smokers	24 (48)	28
Moderate smokers	48–52 (48)	35
Heavy smokers	42 (46) 67–74 (47) 58–78 (48)	54
Sputum		
Heavy smokers	42 (46)	49
Dyspnea		
All smokers	21 (49)	27
Heavy smokers	33 (50)	33

*Numbers in parentheses are reference numbers.
SOURCE: Woolf, C.R. (65).

The relationship between smoking and several respiratory symptoms was examined by Buist et al. in population samples of three North American cities (11). Cough, sputum production, and wheezing occurred more frequently among smokers than nonsmokers regardless of sex.

Bewley and Bland examined the relationships between smoking and the prevalence of respiratory symptoms in 14,033 children aged 10 to 12½ in two separate urban areas of the United Kingdom (9). In this questionnaire survey, 2.5 percent of the girls acknowledged smoking at least one cigarette per week ("smoker"). Boys who smoked outnumbered girls who smoked by 3:1 and were more frequent smokers of at least one cigarette a day than were females by 11:1. Table 11 shows that, even in this young age group, smokers have a higher frequency of morning cough, cough during the day and night, and cough for 3-months duration than their nonsmoking classmates.

In a questionnaire study of a large group of American high school students in Rochester, New York, Rush found a strong association between current smoking and respiratory symptoms in both sexes (47). There were minor differences between sexes in the frequency of respiratory symptoms when